PATENT ABSTRACTS OF JAPAN

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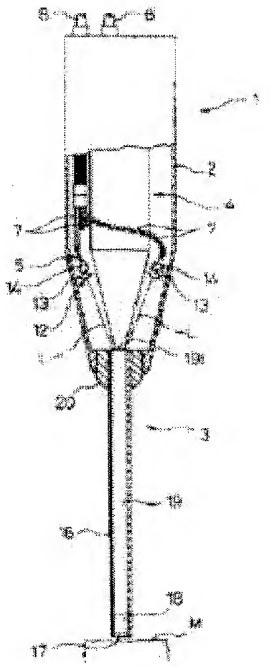
(54) OBSERVATION DEVICE

(57)Abstract:
PURPOSE: To provide a construction for an observation device such as a borescope and an endoscope which has more slender portion including an image transmission body and accurately and effectively illuminates a necessary part, is easily attachable and detachable and is unitized.
CONSTITUTION: Illuminating light given by an optical source system is converged onto a light exit end face of the image transimission body and is made incident on the body. An illuminating system is configured so that the illuminating light, which is made incident on the body, illuminates an observation object through the propagation in the body. The illuminating light from the light emitting source is light guided by plural optical fibers 7 to form the light source system. The tip sections of the optical fiber bundles, in which a unit bundle has an arbitrary number of fibers, are placed in a ring shape. Condenser lenses 13 and 14 are provided corresponding to the unit bundles placed in a ring shape and the illuminating light from the bundles is converged in a ring shape at the peripheral section of a light exit end face 19i of an image transmission body 19.



CLAIMS

[Claim(s)]
[Claim 1]Have a long and slender image transmission body for incorporating an image of an observation object, and have an illumination system for illuminating an observation object, and the illumination system, Illumination light given in a light source system is entered in an image transmission body in condensing from the ejection end face of an image transmission body, It is the viewing device currently formed so that an observation object may be irradiated with illumination light which entered into this image transmission body by the propagation in an image transmission body, While forming a light source system by two or more optical fibers which carry out the light guide of the illumination light from a light source and this light source, and making two or more optical fibers into a unit bunch by a proper number and arranging a tip of each of this unit bunch annularly, A viewing device characterized by making it correspond to annular arrangement of this unit bunch, forming a lens for condensing, and making it make an edge part of the ejection end face of an image transmission body condense illumination light from an optical fiber annularly with a lens for condensing of this annular arrangement.
[Claim 2]Have a long and slender image transmission body for incorporating an image of an observation object, and have an illumination system for illuminating an observation object, and the illumination system, Illumination light given in a light source system is entered in an image transmission body in condensing from the ejection end face of an image transmission body, Are the viewing device currently formed so that an observation object may be irradiated with illumination light which entered into this image transmission body by the propagation in an image transmission body, and a long and slender thin diameter section and a major diameter formed in an end of this thin diameter section in one are included, and. Between a thin diameter section and a major diameter, a path changes continuously, and a refractive-index-distribution type optical transmission body which has a continuous diameter changing part accompanied by a successive change of a refractive-index-distribution state corresponding to a successive change of this path is used for a light source system, A viewing device characterized by making it irradiate the ejection end face of an image transmission body with illumination light from a light source in which this optical transmission body was entered from the end face of a major diameter from the end face of a thin diameter section.
[Claim 3]The viewing device according to any one of claims 1 to 2 using a refractive-index-distribution type image transmission body as an image transmission body.
[Claim 4]A refractive-index-distribution type image transmission body contains a long and slender thin diameter section and a major diameter formed in an end of this thin diameter section in one, and. The viewing device according to claim 3 which is what a path changes continuously between a thin diameter section and a major diameter, and has a continuous diameter changing part accompanied by a successive change of a refractive-index-distribution state corresponding to a successive change of this path.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]This invention relates to the viewing device used for observation of the viewing device or structure of medical application like an endoscope, the internal structure of various equipment, etc.
[0002]
[Description of the Prior Art]Viewing devices used for observation of the endoscope of medical application or a structure, the internal structure of various equipment, etc., such as a bore scope thru/or an image scope, have a thin figure portion which contains a long and slender image transmission body like a refractive-index-distribution type image transmission body or the image transmission body of an image fiber or relay lens structure, for example.
This thin figure portion is inserted in the inside of the body or the inside of apparatus, and is observed.
So, the thin figure portion serves as one certain thing of the performance element of these viewing devices more thinly.
[0003]These viewing devices are provided with the self-illumination system which generally makes a light guide the optical fiber bundle which the thin figure portion was made to meet.
The right and wrong of this illumination system influence that performance greatly.
It is required that a required part can be illuminated correctly and efficiently concrete, for example. For this reason, increase of process cost is to require accuracy high about processing of the end for Lighting Sub-Division of a light guide, and to be caused as a result.
[0004]In the case of the endoscope of medical application, etc., if it can do for prevention, such as infection, to detaching-unit-ize a portion with a possibility of touching human body tissue and body fluid, i.e., a thin figure portion, and to consider it as a disposable type is desired strongly.
However, since the light guide of the self-illumination system has structure mechanically united with the thin figure portion in the conventional endoscope etc., Detaching unit-ization of a thin figure portion has difficulty, and even if detaching-unit-izing is possible, heavy price-ization of the unit will not be able to be avoided, but it will become difficult to consider it as throwing away.

[0005]
[Problem(s) to be Solved by the Invention]About the object for viewing devices with the thin figure portion which this invention was made against the background of such a situation, and contains a long and slender image transmission body, the thin figure portion is made to a thinner thing, and more exact and efficient Lighting Sub-Division of a required part is possible, Detaching-unit-izing of a thin figure portion is still easier, and, moreover, let structure which enables processing of this detaching unit by low cost which is suitable for throwing away be an offer plug.
[0006]
[Means for Solving the Problem]In this invention, have a long and slender image transmission body for incorporating an image of an observation object, and. About a viewing device provided with an illumination system for illuminating an observation object, make the ejection end face of

an image transmission body condense illumination light given in a light source system, and an image transmission body is entered, that illumination system being formed so that an observation object may be irradiated with illumination light which entered into this image transmission body by the propagation in an image transmission body, therefore, While forming a light source system as one structure by two or more optical fibers which carry out the light guide of the illumination light from a light source and this light source, and making two or more optical fibers into a unit bunch by a proper number and arranging a tip of each of this unit bunch annularly, Make it correspond to annular arrangement of this unit bunch, form a lens for condensing, and make it make an edge part of the ejection end face of an image transmission body condense illumination light from an optical fiber annularly with a lens for condensing of this annular arrangement, and as other structures, A long and slender thin diameter section and a major diameter formed in an end of this thin diameter section in one are included, and a path changes continuously between a thin diameter section and a major diameter, and a refractive-index-distribution type optical transmission body which has a continuous diameter changing part accompanied by a successive change of a refractive-index-distribution state corresponding to a successive change of this path is used for a light source system, He is trying to irradiate the ejection end face of an image transmission body with illumination light from a light source in which this optical transmission body was entered from the end face of a major diameter from the end face of a thin diameter section.

[0007]Each of such structures are what used an image transmission body which is a transmission line of an image also [transmission line / of illumination light], and illumination light which entered from the ejection end face of an image transmission body will spread inside of an image transmission body in an opposite direction with image light, will eject it from an incident end face of an image transmission body, and will illuminate an observation object. As a result, an image incorporation range and an illumination range are in agreement, and more exact and efficient Lighting Sub-Division of a required part is attained. It becomes unnecessary to make a light guide of an illumination system meet a thin figure portion like before, and the thin figure portion is made to a thinner thing. Since the main element requires only an image transmission body, in detaching-unit-izing of a thin figure portion, detaching-unit-izing is easy, and, moreover, the low cost-ization can be attained to it.

[0008]It can send in into an image transmission body, without producing interference which becomes an obstacle to an image transmission system about more powerful illumination light in the case of structure which combined an optical fiber and a lens for condensing especially. Namely, since an edge part of the ejection end face of an image transmission body is made to condense illumination light from an optical fiber annularly with a lens for condensing of annular arrangement and he is trying to use a periphery of an image transmission body effectively, It becomes sendable into an image transmission body of powerful illumination light, without affecting image light ejected from the ejection end face of an image transmission body.

[0009]It can send in into an image transmission body, without producing interference which is an easy structure and moreover becomes an obstacle to an image transmission system about very powerful illumination light, in using an optical transmission body which has a continuous diameter changing part. Namely, this optical transmission body has a self-condensing function by that continuous diameter changing part, Supply of illumination light in light-gathering power 1000 times the number [hundreds -] of this is possible by enabling condensing for magnification according to a ratio of a cross-section area of a major diameter, and a cross-section area of a thin diameter section, for example, considering a path of a major diameter as cm order, and considering a path of a thin diameter section as an order below mm. Since influence on image light ejected from the ejection end face of an image transmission body will become what can be disregarded even if this thin diameter section comes to cover the ejection end face of an image transmission body if a thin diameter section is very thin like below mm, The central part of the ejection end face of an image transmission body is made to face the end face of a thin diameter section directly, and it becomes possible to take the easiest structure [say / irradiating with illumination light to inside of an image transmission body].

[0010]To a long and slender image transmission body, about both structure using the above-

mentioned lens for condensing, and structure using a self-condensing type optical transmission body. Although it is preferred to use a refractive-index-distribution type image transmission body, said image fiber, a relay type image transmission body, etc. other than this refractive-index-distribution type image transmission body can be used, for example.
[0011]A long and slender thin diameter section and a major diameter formed in an end of this thin diameter section in one are included in a refractive-index-distribution type image transmission body, and. It is still more desirable if a refractive-index-distribution type image transmission body which a path changes continuously and has a continuous diameter changing part accompanied by a successive change of a refractive-index-distribution state corresponding to a successive change of this path is used between a thin diameter section and a major diameter. That is, according to such a refractive-index-distribution type image transmission body, since the path of the ejection end face is large, more illumination light can be entered efficiently, and the more powerful Lighting Sub-Division power can be obtained.
[0012]The above refractive-index-distribution type optical transmission bodies of different diameter structure can be formed by the interface gel polymerizing method, when using a polymer raw material. The fundamental process of this interface gel polymerizing method is as follows.
[0013]Namely, several monomers as for which the interface gel polymerizing method differs in a refractive index and molecular size, respectively or an unreacted nature child's mixed liquor, It is made to polymerize with specific directivity by use of a gel effect within a polymerization pipe formed with a high material of a monomer in mixed liquor, an unreacted nature child, and compatibility, for example, a specific monomer of mixed liquor, an unreacted nature child or the mixed liquor itself, and an affiliated polymer raw material, According to a difference of the diffusibility of each monomer in this polymerization process or an unreacted nature child. Refractive index distribution in a radial direction is given by carrying out mixed distribution of several monomers or unreacted nature children from whom a refractive index differed, respectively by a ratio which applied on the outskirts and is eventually different from a medial axis of a polymerization pipe (for example, JP,H4-97302,A, JP,H4-97303,A).
[0014]As the technique of enforcing such an interface gel polymerizing method, there are an injection method and a dropping test, for example. An injection method is the method of polymerizing all pouring in a monomer of a complement, or an unreacted nature child's mixed liquor into a polymerization pipe at once, and rotating a polymerization pipe. On the other hand, a dropping test is a method advances a polymerization for every dropping and it was made to fill a polymerization pipe with a polymer solid eventually, trickling mixed liquor of a monomer or an unreacted nature child with the specified quantity in a polymerization pipe.
[0015]To a method of forming an optical transmission body by this invention using the above interface gel polymerizing methods, the following two kinds of methods are possible. One is the pure extending method and it is a method adapting a technique regularly used as a process of the conventional optical fiber. A long and slender thin diameter section is formed by forming an intermediate (called preforming) in cylindrical shape of uniform thickness using an injection method or a dropping test first, carrying out heat softening of the end side of this intermediate, and subsequently, specifically extending it selectively. It being important as this invention is forming a continuous diameter changing part which it is made to leave in one with a thin diameter section as it is by having used a part of intermediate with a thick path as a major diameter, and controlled a state of path change by enlargement between a major diameter and a thin diameter section here. Thus, so to speak in a continuous diameter changing part controlled by predetermined state, a refractive-index-distribution state in an intermediate changes continuously in the shape of similarity corresponding to continuation change of a path.
[0016]Other one is the mixing method and it differs from said pure extending method in that a plastic element is taken in to processing of an intermediate. An intermediate is formed using a polymerization pipe fabricated in preliminary shape used as a skeleton of shape of an optical transmission body specifically eventually made profitably like, this intermediate is processed like the aforementioned pure extending method, and the target optical transmission body is obtained. A dropping test is used for formation of an intermediate in this case. That is, a polymer solid is

formed, mixed liquor of a monomer or an unreacted nature child being dropped one by one under a predetermined control condition in a polymerization pipe fabricated in preliminary shape. In a continuous diameter changing part of a polymerization pipe beforehand given in this process, Mixed liquor of a monomer dropped one by one or an unreacted nature child polymerizes under conditions of a different path for every dropping, mixed distribution ratios of a different-species monomer or an unreacted nature child differ according to a difference of path conditions in this polymerization, this is piled up, and a successive change of a refractive-index-distribution state is obtained.

[0017]As a polymer raw material which can be used by the interface gel polymerizing method, the following is possible. MMA (Methyl Methacrylate and molecular size;104.4, refractive-index;1.492), BBP (Benzyl n-Butyl Phthalate and molecular size;301.1, refractive-index;1.541), BzMA (Benzyl Methacrylate and molecular size;180.0, refractive-index;1.562), VB (Vinyl Benzoate and molecular size;145.9, refractive-index;1.578), PhMA (Phenyl Methacrylate and molecular size;162.8, refractive-index;1.570) and VPAc (Vinyl Phenylacetate and molecular size;163.2, refractive-index;1.567).

[0018]

[Example]Hereafter, working example of this invention is described. The image pick-up implement 1 with which this working example is an example about the video-type viewing device which consists of a monitor display besides the figure which carries out the repeat display of the image of the observation object caught with the image pick-up implement 1 shown in drawing 1 which used the solid state image pickup device, and this image pick-up implement 1, and the feature of this invention is included consists of the body part 2 and the image transmission body unit 3.

[0019]The body part 2 is cylindrical, and build the camera unit 4 in the inside, and. The optical fibers 7 and 7 of a large number which build in the light source system unit 5 which forms the light source system which is a part of illumination system, and are contained in the signal cable 6 and the light source system unit 5 from the imaging unit 4, and the light source cable 8 which bundled .... are installed outside, respectively.

[0020]The imaging unit 4 provides the diaphragms 11 and 11 for prevention of the solid state image pickup device 10 of a camera unit, the flare, etc., ..., etc. in the inside of the protection-from-light pipe 9 to which the front end part is thin to conical shape, as shown in drawing 2.

[0021]The optical fibers 7 and 7 of a large number to which the light source system unit 5 carries out the light guide of the illumination light from an external light source, and ...., It consists of the condensing system unit 12 for making the edge part of the ejection end face 19i of the below-mentioned image transmission body 19 carry out image formation of these optical fibers 7 and 7 and the illumination light of .... ejected from an apical surface, i.e., an irradiation end side, in a circle, and condensing.

[0022]The condensing system unit 12 is what attaches the collimating lens 14 which the image formation lens 13 was made to correspond to the proper number and each of this image formation lens 13, and was provided to the frame without front fork which omitted the graphic display, He is trying for the optical fibers 7 and 7 and the optical fiber bundle 7b made into the unit by the proper number from .... to correspond to each collimating lens 14. And the illumination light L by which image formation was carried out with this condensing system unit 12 will enter into the image transmission body 19 from the edge part of the ejection end face 19i, will spread that inside, and will irradiate with the observation object M.

[0023]The image transmission body unit 3 arranges the cover glass 17, the object lens 18, and the refractive-index-distribution type image transmission body 19 from a tip in the long and slender protective tube 16 at order, and it has attached the screwing member 20 to the base end of the protective tube 16.

The body part 2 enables it to be detached and attached via this screwing member 20.

[0024]It is an example using the refractive-index-distribution type image transmission body 30 of a structure special as modification of above-mentioned working example which is shown in drawing 3. That is, this image transmission body 30 has the structure in which the continuous diameter changing part 35 to which a path becomes small continuously towards the thin diameter

section 34 side was formed from the major diameter 32 side between the short major diameter 32 by which that end face was made the ejection end face 31, and the long and slender thin diameter section 34 by which that end face was made the incident end face 33.
[0025]Although transmission of an image is made by optical-path locus T' as shown with a dashed line in a figure and the image which entered from the incident end face 33 like the usual refractive-index-distribution type image transmission body in the thin diameter section 34 is transmitted by actual size, this image transmission body 30, It applies to the major diameter 32 from the continuous diameter changing part 35, and expands gradually, and image formation is eventually carried out to 10 f of acceptance surfaces of the solid state image pickup device 10 as an image of the magnification according to the ratio of the path of the ejection end face 31 and the incident end face 33.
[0026]On the other hand, the illumination light L from the condensing system unit 12 which enters from the ejection end face 31 will spread the inside of the image transmission body 30 to this image transmission body 30 for reverse with the above-mentioned image transmission, and will irradiate it with an observation object from the incident end face 33. That is, it will irradiate with an observation object from the incident end face 33 of a byway, the illumination light which entered being condensed in the continuous diameter changing part 35 from the ejection end face 31 of a major diameter. Since according to such an image transmission body 30 the illumination light from the condensing system unit 12 can be entered efficiently and image transmission body 30 the very thing moreover has light-gathering power, the very powerful Lighting Sub-Division power can be obtained.
[0027]Although he is trying to produce in this example in 10 f of acceptance surfaces of the solid state image pickup device 10 which has an image formation face of the image transmission body 30 in the position which is distant from the ejection end face 31, By adjusting the relation between the distance of the incident end face 33 and the ejection end face 31, and the pitch number of optical-path locus T', an image formation face can be produced on the ejection end face 31. However, it is necessary to establish an image formation system between the solid state image pickup devices 10 in that case. Although the major diameter 32 which has a certain length in the image transmission body 30 of this example is formed, the structure where it is not necessary to necessarily form such a major diameter 32, and the ejection end face 31 is given to the end of the continuous diameter changing part 35 is also possible.
[0028]What is shown in drawing 4 is the example which used the image transmission body 30 in the 2nd working example of the above, and the optical transmission body 40 of the same structure for the condensing system of the light source system. Namely, the short major diameter 42 which has the 1st end face 41 (it corresponds to the ejection end face 31 of the image transmission body 30) where the optical transmission body 40 used for the condensing system was made into a diameter of about 1 cm, It is the structure in which the continuous diameter changing part 45 was formed between the long and slender thin diameter sections 44 which have the 2nd end face 43 (it corresponds to the incident end face 33 of the image transmission body 30) made into the diameter of about 0.5 mm.
The illumination light is transmitted in condensing like the image transmission body 30.

[0029]This optical transmission body 40 by bending that thin diameter section 44 by the pliability which it has, The 1st end face 41 faces the ejection end face of the optical fiber bundle 47, and on the other hand, the 2nd end face 43 changes into the state of facing the abbreviated central part of the ejection end face 19i of the image transmission body 19, and you are made to be placed between it between the ejection end face of the optical fiber bundle 47, and the ejection end face 19i of the image transmission body 19. That is, the illumination light L from the optical fiber bundle 47. It enters into the optical transmission body 40 from the 1st end face 41, and it ejects from the 2nd end face 43 to the ejection end face 19i of the image transmission body 19 as powerful illumination light condensed about 400 times by simple calculation in the continuous diameter changing part 45, the inside of the image transmission body 19 is spread further, and it irradiates with an observation object.
[0030]It is a modification of working example of drawing 4 which is shown in drawing 5, and it is

the example which used for the light source system the optical transmission body 50 which has the thin diameter section 54 long enough. Namely, in this example, it differs from the optical transmission body 40 in working example of drawing 4 having been used as a condensing system of a light source system, After the continuous diameter changing part 55 is condensed, he is trying to be led by the thin diameter section 54 long enough even in the ejection end face 19i of the image transmission body 19 in the illumination light L from the light source Ls into which it is made for the major diameter 52 of the optical transmission body 50 to face the external light source Ls directly, and it entered from the 1st end face 51 of the major diameter 52.
[0031]Although the refractive-index-distribution type image transmission body was used for the image transmission body in each above working example, In addition, the image transmission body 60 of the image fiber known well, for example or relay structure as shown in drawing 6, i.e., the image transmission body etc. which repeat actual size image formation with two or more lenses 61a and 61b arranged to series, and transmit an image, can be used.
[0032]
[Effect of the Invention]Since he is trying to use the long and slender image transmission body which is a transmission line of an image also [transmission line / of the illumination light] as the viewing device by this invention has been explained above, More exact and efficient Lighting Sub-Division of a required part is possible, and a thin figure portion is made to a thinner thing, and detaching unit-ization by the low cost of a thin figure portion is enabled further. And by considering it as the structure using the optical transmission body which has the structure and the continuous diameter changing part which combined the optical fiber and the lens for condensing especially, Since it can send in into an image transmission body, without producing interference which becomes an obstacle to an image transmission system about the more powerful illumination light, the above-mentioned strong point can be demonstrated more effectively.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
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3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]A side view including the partial section of the image pick-up implement by one working example of this invention.
[Drawing 2]The partial expanded sectional view of the image pick-up implement of drawing 1.
[Drawing 3]The partial lineblock diagram of the image pick-up implement by the 2nd working example of this invention.
[Drawing 4]The partial lineblock diagram of the image pick-up implement by the 3rd working example of this invention.
[Drawing 5]The partial lineblock diagram of the image pick-up implement by the 4th working example of this invention.
[Drawing 6]The sectional view of the image transmission body by other examples.
[Description of Notations]
1 Image pick-up implement
2 Body part
3 Image transmission body unit
5 Light source system unit
7 Optical fiber
7b Optical fiber bundle (unit bunch)
10 Image sensor
10 f Acceptance surface
13 The lens for image formation
19 Image transmission body
19i Ejection end face
30 Image transmission body
31 Ejection end face
33 Incident end face
35 Continuous diameter changing part
40 Optical transmission body
41 The 1st end face
43 The 2nd end face
45 Continuous diameter changing part
M Observation object
L Illumination light

[Translation done.]

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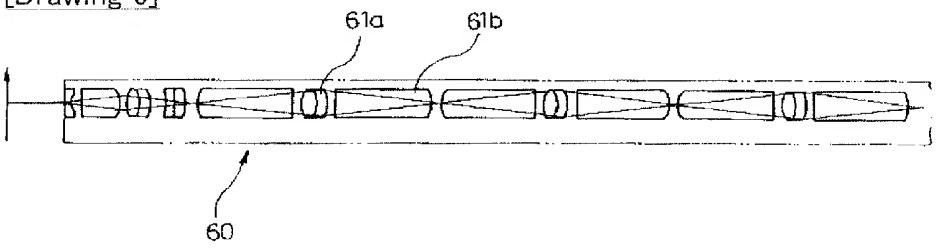
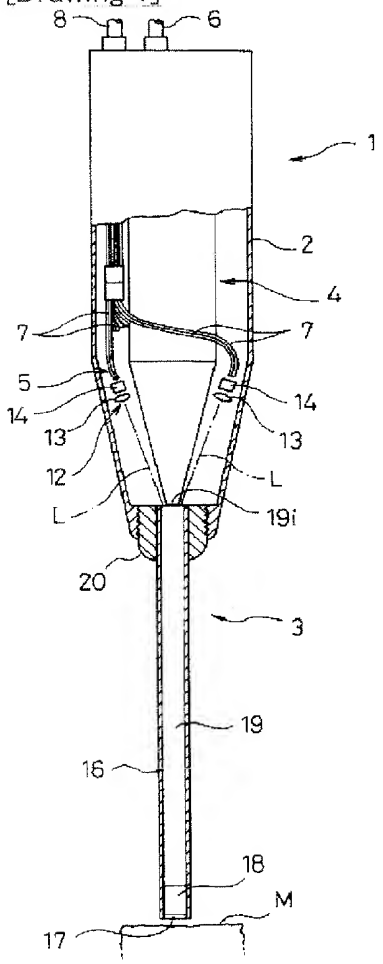
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

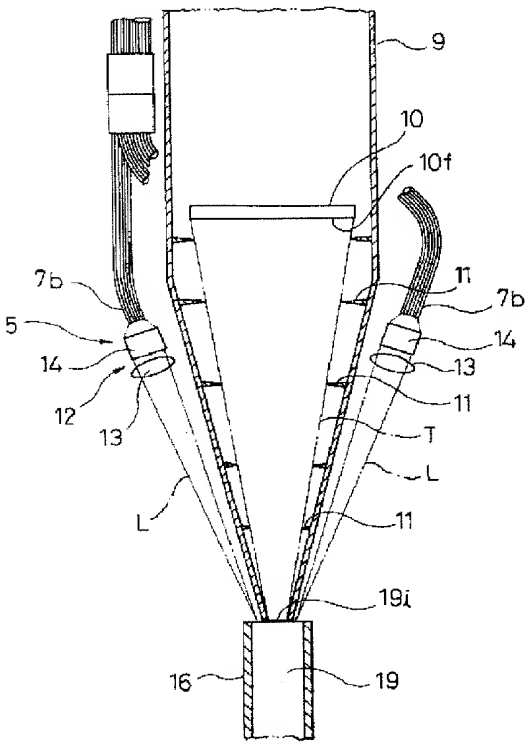
[Drawing 6]



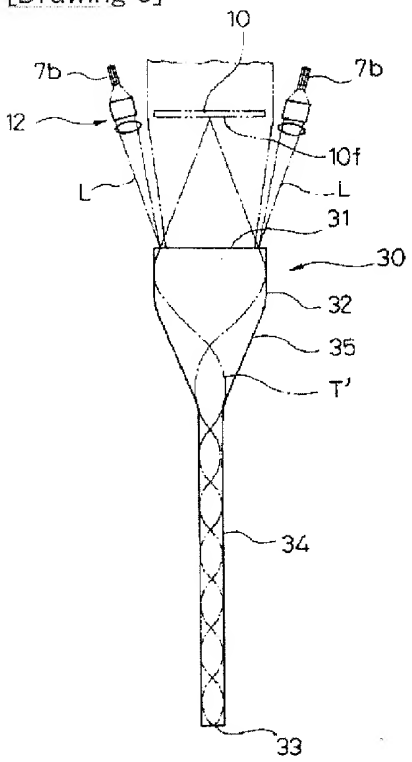
[Drawing 1]



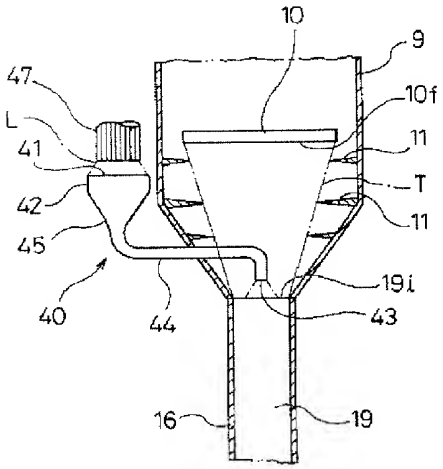
[Drawing 2]



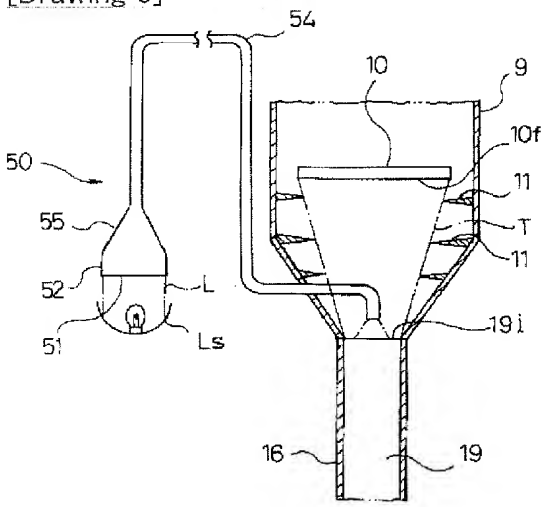
[Drawing 3]



[Drawing 4]



[Drawing 5]



[Translation done.]

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審査請求　未請求　請求項の数４　ＦＤ　（全　６　頁）

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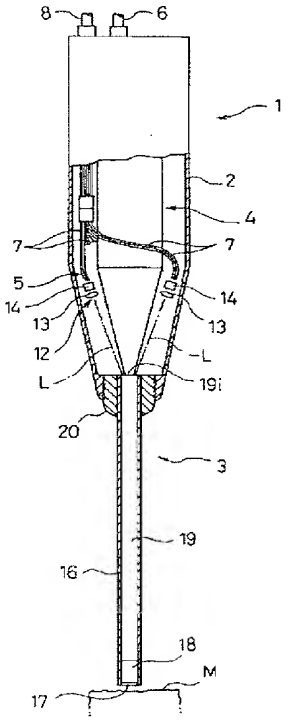
(54)【発明の名称】　観察装置

(57)【要約】

【目的】例えばボアスコープや内視鏡のように細長い像伝送体を含む細身部分を有する観察装置用について、その細身部分をより細いものにでき、また必要な部位のより正確且つ効率的な照明が可能で、さらに細身部分の着脱ユニット化が容易であるような構造の提供。

【構成】光源系にて与えられる照明光を像伝送体の射出端面に集光させて像伝送体に入射させ、この像伝送体に入射した照明光を像伝送体中の伝搬により観察物に照射するように照明系を形成するものとし、そのために、発光源からの照明光を複数の光ファイバ７にて導光して光源系を形成すると共に、適宜の本数で単位束とした光ファイバ束の先端を環状に配列し、この単位束の環状配列に対応させて設けた集光用レンズ１３、１４にて光ファイバ束よりの照明光を像伝送体１９の射出端面１９ｉの周縁部に環状に集光させるようにしている。



【特許請求の範囲】
【請求項１】　観察物の像を取り込むための細長い像伝送体を備えると共に、観察物を照明するための照明系を備えてなり、その照明系は、光源系にて与えられる照明光を像伝送体の射出端面から像伝送体に集光的に入射させ、この像伝送体に入射した照明光を像伝送体中の伝搬により観察物に照射するように形成されている観察装置であって、発光源とこの発光源から照明光を導光する複数の光ファイバとにより光源系を形成し且つ、複数の光ファイバを適宜の本数で単位束とし、この各単位束の先端を環状に配列する一方で、この単位束の環状配列に対応させて集光用レンズを設け、この環状配列の集光用レンズにて光ファイバよりの照明光を像伝送体の射出端面の周縁部に環状に集光させるようにしたことを特徴とする観察装置。
【請求項２】　観察物の像を取り込むための細長い像伝送体を備えると共に、観察物を照明するための照明系を備えてなり、その照明系は、光源系にて与えられる照明光を像伝送体の射出端面から像伝送体に集光的に入射させ、この像伝送体に入射した照明光を像伝送体中の伝搬により観察物に照射するように形成されている観察装置であって、細長い細径部とこの細径部の一端に一体的に形成された大径部とを含むと共に、細径部と大径部の間に、連続的に径が変化し且つこの径の連続的変化に対応した屈折率分布状態の連続的変化を伴う連続的径変化部を有してなる屈折率分布型の光伝送体を光源系に用い、この光伝送体に大径部の端面から入射させた発光源よりの照明光を細径部の端面から像伝送体の射出端面に照射するようにしたことを特徴とする観察装置。
【請求項３】　像伝送体として、屈折率分布型の像伝送体を用いた請求項１～請求項２の何れかに記載の観察装置。
【請求項４】　屈折率分布型の像伝送体が、細長い細径部とこの細径部の一端に一体的に形成された大径部とを含むと共に、細径部と大径部の間に、連続的に径が変化し且つこの径の連続的変化に対応した屈折率分布状態の連続的変化を伴う連続的径変化部を有してなるものである請求項３に記載の観察装置。
【発明の詳細な説明】
【０００１】
【産業上の利用分野】本発明は、内視鏡のような医療用の観察装置あるいは構造物や各種機器の内部構造等の観察に用いる観察装置に関する。
【０００２】
【従来の技術】医療用の内視鏡、あるいは構造物や各種機器の内部構造等の観察に用いるボアスコープ乃至イメージスコープ等の観察装置は、例えば屈折率分布型像伝送体やイメージファイバあるいはリレーレンズ構造の像伝送体のような細長い像伝送体を含む細身部分を有しており、この細身部分を体内や機器の内部に挿入して観察するようになっている。それ故、その細身部分がより細くあることがこれらの観察装置の性能要素の一つとなる。
【０００３】また、これらの観察装置は、一般に、細身部分に沿わせた光ファイバ束をライトガイドとする自己照明系を備えており、この照明系の善し悪しがその性能に大きく影響する。具体的には、例えば必要な部位を正確に且つ効率的に照明できることが要求される。このため、ライトガイドの照明用端部の加工について高い精度が要求され、その結果加工コストの増大を招くことになっている。
【０００４】さらに、医療用の内視鏡等の場合には、感染等の防止のために出来れば人体組織や体液に触れるおそれのある部分、つまり細身部分を着脱ユニット化して使い捨て式とすることが強く望まれる。ところが、従来の内視鏡等においては、その自己照明系のライトガイドが細身部分と機械的に一体化した構造となっているので、細身部分の着脱ユニット化に困難があり、またたとえ着脱ユニット化が可能であっても、そのユニットの高価格化を避けられず、使い捨てとすることが難しくなってしまう。
【０００５】
【発明が解決しようとする課題】このような事情を背景になされたのが本発明で、細長い像伝送体を含む細身部分を有した観察装置用について、その細身部分をより細いものにでき、また必要な部位のより正確且つ効率的な照明が可能で、さらに細身部分の着脱ユニット化が容易で、しかもこの着脱ユニットを使い捨てに適するような低コストで加工可能とする構造を提供せんとするものである。
【０００６】
【課題を解決するための手段】本発明では、観察物の像を取り込むための細長い像伝送体を備えると共に、観察物を照明するための照明系を備えてなる観察装置について、光源系にて与えられる照明光を像伝送体の射出端面に集光させて像伝送体に入射させ、この像伝送体に入射した照明光を像伝送体中の伝搬により観察物に照射するようにその照明系を形成するものとしており、そのために、一つの構造として、発光源とこの発光源から照明光を導光する複数の光ファイバとにより光源系を形成し且つ、複数の光ファイバを適宜の本数で単位束とし、この各単位束の先端を環状に配列する一方で、この単位束の環状配列に対応させて集光用レンズを設け、この環状配列の集光用レンズにて光ファイバよりの照明光を像伝送体の射出端面の周縁部に環状に集光させるようにし、また他の構造として、細長い細径部とこの細径部の一端に一体的に形成された大径部とを含むと共に、細径部と大径部の間に、連続的に径が変化し且つこの径の連続的変化に対応した屈折率分布状態の連続的変化を伴う連続的径変化部を有してなる屈折率分布型の光伝送体を光源系

に用い、この光伝送体に大径部の端面から入射させた発光源よりの照明光を細径部の端面から像伝送体の射出端面に照射するようにしている。

【０００７】これらの各構造は、像の伝送路である像伝送体を照明光の伝送路にも兼用するようにしたもので、像伝送体の射出端面から入射した照明光は、像伝送体中を像光とは逆方向で伝搬し、像伝送体の入射端面から射出して観察物を照明することになる。この結果、像取込み範囲と照明範囲が一致し、必要な部位のより正確且つ効率的な照明が可能となる。また、従来のように照明系のライトガイドを細身部分に沿わせる必要がなくなり、その細身部分をより細いものにできる。さらに、細身部分の着脱ユニット化の場合に、その主な要素が像伝送体だけで済むので、着脱ユニット化が容易であり、しかもその低コスト化を図れる。

【０００８】特に、光ファイバと集光用レンズを組み合わせた構造の場合には、より強力な照明光を像伝送系に対し障害となるような干渉を生じることなく像伝送体中に送り込むことができる。即ち、環状配列の集光用レンズにて光ファイバよりの照明光を像伝送体の射出端面の周縁部に環状に集光させて像伝送体の周縁を有効に利用するようにしているので、像伝送体の射出端面から射出する像光に影響を与えることなく、強力な照明光の像伝送体中への送り込みが可能となる。

【０００９】また、連続的径変化部を有する光伝送体を用いる場合には、非常に強力な照明光を簡単な構造で、しかも像伝送系に対し障害となるような干渉を生じることなく、像伝送体中に送り込むことができる。即ち、この光伝送体は、その連続的径変化部により自己集光機能を持ち、大径部の断面積と細径部の断面積との比率に応じた倍率での集光を可能とし、例えば大径部の径をｃｍオーダーとし細径部の径をｍｍ以下のオーダーとすることにより、数百～数千倍の集光力での照明光の供給が可能である。また、細径部がｍｍ以下というように極めて細いと、この細径部が像伝送体の射出端面に被さるようになっても像伝送体の射出端面から射出する像光への影響は無視し得るものとなるので、細径部の端面を像伝送体の射出端面の中心部に直接臨ませて像伝送体中への照明光の照射を行うという、最も簡単な構造を採ることが可能となる。

【００１０】上記の集光用レンズを用いる構造及び自己集光型の光伝送体を用いる構造の何れについても、細長い像伝送体には、屈折率分布型の像伝送体を用いるのが好ましいが、この屈折率分布型像伝送体の他にも、例えば前記イメージファイバやリレータイプの像伝送体等を用いることができる。

【００１１】屈折率分布型の像伝送体には、細長い細径部とこの細径部の一端に一体的に形成された大径部とを含むと共に、細径部と大径部の間に、連続的に径が変化し且つこの径の連続的変化に対応した屈折率分布状態の連続的変化を伴う連続的径変化部を有してなる屈折率分布型の像伝送体を用いれば、さらに好ましい。即ち、このような屈折率分布型像伝送体によると、射出端面の径が大きいのでより多く照明光を効率的に入射させることができ、より強力な照明力を得ることができる。

【００１２】上記のような異径構造の屈折率分布型の光伝送体は、ポリマー原料を用いる場合には界面ゲル重合法により形成することができる。この界面ゲル重合法の基本的プロセスは以下の通りである。

【００１３】即ち、界面ゲル重合法は、それぞれ屈折率及び分子サイズのそれぞれ異なる複数のモノマー又は未反応性分子の混合液を、混合液中のモノマーや未反応性分子と親和性の高い材料、例えば混合液の特定のモノマーや未反応性分子又は混合液自体と同系のポリマー原料で形成した重合管内でゲル効果の利用により特定の方向性をもって重合させ、この重合過程における各モノマー又は未反応性分子の拡散性の相違により、それぞれ屈折率の異なった複数のモノマー又は未反応性分子を最終的に重合管の中心軸から周辺にかけて異なった比率で混合分布させることにより半径方向での屈折率分布を与えるようにしたものである（例えば、特開平４－９７３０２号、特開平４－９７３０３号）。

【００１４】このような界面ゲル重合法を実施する手法としては、例えば、注入法と滴下法がある。注入法は、必要な量のモノマー又は未反応性分子の混合液を全部一度に重合管内に注入し、それから重合管を回転させつつ重合を行う方法である。一方、滴下法は、モノマー又は未反応性分子の混合液を重合管内に所定量で滴下しつつ、各滴下ごとに重合を進め、最終的に重合管をポリマー固体で満たすようにした方法である。

【００１５】以上のような界面ゲル重合法を用いて本発明による光伝送体を形成する方法には、以下の２通りの方法が可能である。一つは純延伸法で、従来の光ファイバの製法として常用されている手法を応用した方法である。具体的には、先ず注入法又は滴下法を用いて中間体（プリフォームとも呼ばれる）を均一な太さの円柱状に形成し、次いでこの中間体の一端側を加熱軟化させて部分的に引き伸ばすことにより、細長い細径部を形成する。ここで本発明として大事なことは、径の太い中間体の一部をそのまま大径部として細径部と一体的に残すようにし、且つ大径部と細径部との間に引き伸ばしによる径変化の状態を制御した連続的径変化部を形成することである。このように所定の状態に制御された連続的径変化部では中間体における屈折率分布状態が径の連続変化に対応して言わば相似状に連続的に変化する。

【００１６】他の一つはミックス法で、中間体の加工に成形的な要素を取り入れる点で前記純延伸法と異なる。具体的には、最終的に得ようとする光伝送体の形状の骨格となる予備的形状に成形した重合管を用いて中間体を形成し、この中間体を前記の純延伸法と同様に処理して

目的の光伝送体を得るようにする。この場合の中間体の形成には滴下法が用いられる。つまり、予備的形状に成形した重合管内にモノマー又は未反応性分子の混合液を所定の制御条件下で順次滴下しつつポリマー固体を形成する。この過程では、予め与えられている重合管の連続的径変化部において、順次滴下されるモノマー又は未反応性分子の混合液が各滴下ごとに異なる径の条件下で重合をなし、この重合における径条件の相違に応じて異種モノマー又は未反応性分子の混合分布比率が異なり、これが積み重なって屈折率分布状態の連続的変化が得られる。

【００１７】界面ゲル重合法で用いることができるポリマー原料としては、以下のようなものが可能である。ＭＭＡ（Methyl Methacrylate, 分子サイズ;104.4, 屈折率;1.492）、ＢＢＰ(Benzyl n−Butyl Phthalate, 分子サイズ;301.1, 屈折率;1.541)、ＢｚＭＡ(Benzyl Methacrylate, 分子サイズ;180.0, 屈折率;1.562)、ＶＢ（Vinyl Benzoate, 分子サイズ;145.9, 屈折率;1.578）、ＰｈＭＡ（Phenyl Methacrylate, 分子サイズ;162.8, 屈折率;1.570）、ＶＰＡｃ（Vinyl Phenylacetate, 分子サイズ;163.2, 屈折率;1.567）。

【００１８】

【実施例】以下、本発明の実施例を説明する。この実施例は固体撮像素子を用いた図１に示す撮像具１とこの撮像具１で捉えた観察物の像を再生表示する図外のモニタディスプレイからなるビデオ式の観察装置に関する例で、本発明の特徴が含まれる撮像具１は、本体部２と像伝送体ユニット３よりなっている。

【００１９】本体部２は、筒状で、その内部にカメラユニット４を内蔵すると共に、照明系の一部である光源系を形成する光源系ユニット５を内蔵し、また撮像ユニット４からの信号ケーブル６及び光源系ユニット５に含まれる多数の光ファイバ７、７、……を束ねた光源ケーブル８がそれぞれ外部へ延設されている。

【００２０】撮像ユニット４は、図２に示すように、前端部分が円錐状に細くなっている遮光筒９の内部にカメラユニットの固体撮像素子１０やフレア等の防止のための絞り１１、１１、……等を設けてなっている。

【００２１】光源系ユニット５は、外部の発光源から照明光を導光する多数の光ファイバ７、７、……と、これらの光ファイバ７、７、……の先端面つまり照射端面から射出される照明光を後述の像伝送体１９の射出端面１９ｉの周縁部に円環状に結像させて集光するための集光系ユニット１２とよりなっている。

【００２２】集光系ユニット１２は、結像レンズ１３を適宜の個数と、この結像レンズ１３の各々に対応させて設けたコリメータレンズ１４とを図示を省略したフレーム体に組み付けてなるもので、各コリメータレンズ１４には光ファイバ７、７、……から適宜の本数で単位とした光ファイバ束７ｂが対応するようにされている。そして、この集光系ユニット１２により結像された照明光Ｌは、射出端面１９ｉの周縁部から像伝送体１９に入射し、その内部を伝搬して観察物Ｍを照射することになる。

【００２３】像伝送体ユニット３は、細長い保護筒１６内に先端から順にカバーガラス１７、対物レンズ１８、及び屈折率分布型の像伝送体１９を配列すると共に、保護筒１６の基端部に螺合部材２０を取り付けてなっており、この螺合部材２０を介して本体部２に着脱できるようにされている。

【００２４】図３に示すのは、上記実施例の変形として特殊な構造の屈折率分布型像伝送体３０を用いた例である。即ち、この像伝送体３０は、その端面が射出端面３１とされた短い大径部３２と、その端面が入射端面３３とされた細長い細径部３４との間に大径部３２側から細径部３４側に向けて連続的に径が小さくなる連続的径変化部３５を形成した構造となっている。

【００２５】この像伝送体３０は、図中に１点鎖線で示すような光路軌跡Ｔ′で像の伝送がなされ、細径部３４においては通常の屈折率分布型像伝送体と同様に入射端面３３から入射した像が等倍で伝送されるが、連続的径変化部３５から大径部３２にかけて徐々に拡大し、最終的には射出端面３１と入射端面３３の径の比率に応じた倍率の像として固体撮像素子１０の受光面１０ｆに結像するものである。

【００２６】一方、この像伝送体３０に射出端面３１から入射する集光系ユニット１２よりの照明光Ｌは、上記像伝送とは逆向きで像伝送体３０内を伝搬して入射端面３３から観察物を照射することになる。つまり、大径の射出端面３１から入射した照明光が連続的径変化部３５において集光されつつ小径の入射端面３３から観察物を照射することになる。このような像伝送体３０によると、集光系ユニット１２からの照明光を効率よく入射させることができ、しかも像伝送体３０自体が集光力を持つので、極めて強力な照明力を得ることができる。

【００２７】尚、この例では像伝送体３０の結像面が射出端面３１から離れた位置にある固体撮像素子１０の受光面１０ｆに生じるようにされているが、入射端面３３と射出端面３１との距離と光路軌跡Ｔ′のピッチ数との関係を調整することにより、射出端面３１上に結像面を生じさせるようにすることもできる。ただ、その場合には固体撮像素子１０との間に結像系を設ける必要がある。また、この例の像伝送体３０にはある長さを持つ大径部３２が形成されているが、必ずしもこのような大径部３２を設ける必要はなく、連続的径変化部３５の一端に射出端面３１を与えるような構造も可能である。

【００２８】図４に示すのは、上記第２の実施例における像伝送体３０と同様の構造の光伝送体４０を光源系の集光系に用いた例である。即ち、集光系に用いた光伝送体４０は、約１ｃｍの直径とされた第１端面４１（像伝

送体３０の射出端面３１に対応する）を有する短い大径部４２と、約0.５ｍｍの直径とされた第２端面４３（像伝送体３０の入射端面３３に対応する）を有する細長い細径部４４との間に連続的径変化部４５を形成した構造であり、像伝送体３０と同様にして照明光を集光的に伝送するようになっている。

【００２９】この光伝送体４０は、それが持つ柔軟性でその細径部４４を曲折させることにより、第１端面４１が光ファイバ束４７の射出端面と向かい合い、一方第２端面４３が像伝送体１９の射出端面１９ｉの略中心部に向かい合う状態にして、光ファイバ束４７の射出端面と像伝送体１９の射出端面１９ｉとの間に介在させられている。つまり、光ファイバ束４７からの照明光Ｌは、第１端面４１から光伝送体４０に入射し、連続的径変化部４５において単純計算で約４００倍に集光された強力な照明光として第２端面４３から像伝送体１９の射出端面１９ｉに射出し、さらに像伝送体１９内を伝搬して観察物を照射する。

【００３０】図５に示すのは、図４の実施例の変形例で、十分に長い細径部５４を有する光伝送体５０を光源系に用いた例である。即ち、この例では、図４の実施例における光伝送体４０が光源系の集光系として用いられていたのと異なり、光伝送体５０の大径部５２が外部の発光源Ｌｓに直接臨むようにされ、大径部５２の第１端面５１から入射した発光源Ｌｓからの照明光Ｌが連続的径変化部５５が集光された後、十分に長い細径部５４により像伝送体１９の射出端面１９ｉにまで導かれるようにされている。

【００３１】以上の各実施例では像伝送体に屈折率分布型の像伝送体を用いていたが、この他に、例えばよく知られているイメージファイバ、あるいは図６に示すようなリレー構造の像伝送体６０、つまり直列に配列した複数のレンズ６１ａ、６１ｂで等倍結像を繰り返して像の伝送を行う像伝送体等を用いることができる。

【００３２】

【発明の効果】本発明による観察装置は、以上説明してきた如く、像の伝送路である細長い像伝送体を照明光の伝送路にも兼用するようにしているので、必要な部位のより正確且つ効率的な照明が可能であり、また細身部分をより細いものにでき、さらに細身部分の低コストでの着脱ユニット化を可能とする。そして、特に、光ファイバと集光用レンズを組み合わせた構造及び連続的径変化部を有する光伝送体を用いる構造とすることにより、より強力な照明光を像伝送系に対し障害となるような干渉を生じることなく像伝送体中に送り込むことができるので、上記の長所をより有効に発揮させることができる。

【図面の簡単な説明】

【図１】本発明の一実施例による撮像具の一部断面を含む側面図。

【図２】図１の撮像具の部分拡大断面図。

【図３】本発明の第２の実施例による撮像具の部分構成図。

【図４】本発明の第３の実施例による撮像具の部分構成図。

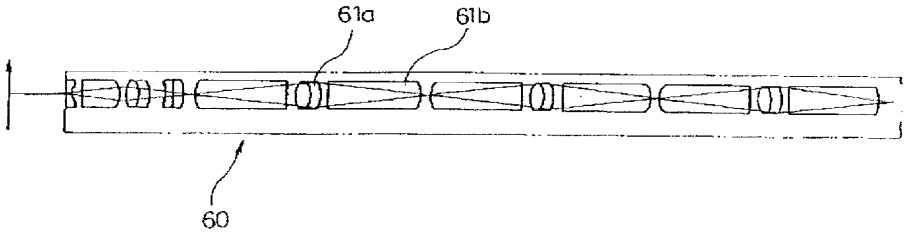
【図５】本発明の第４の実施例による撮像具の部分構成図。

【図６】他の例による像伝送体の断面図。

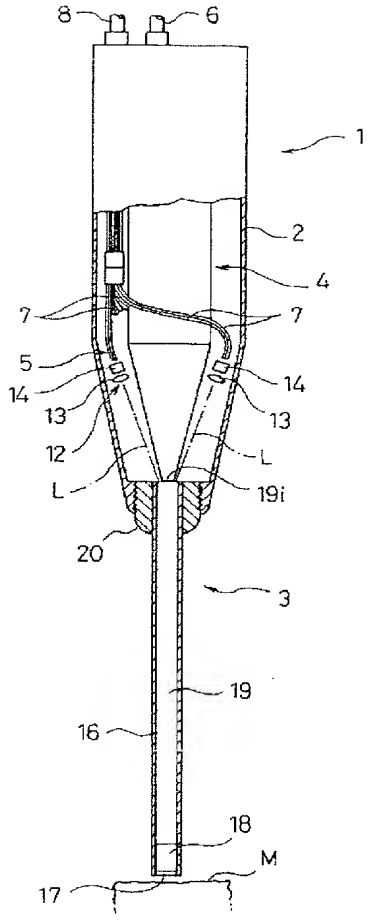
【符号の説明】

１　撮像具
２　本体部
３　像伝送体ユニット
５　光源系ユニット
７　光ファイバ
７ｂ　光ファイバ束（単位束）
１０　撮像素子
１０ｆ　受光面
１３　結像用レンズ
１９　像伝送体
１９ｉ　射出端面
３０　像伝送体
３１　射出端面
３３　入射端面
３５　連続的径変化部
４０　光伝送体
４１　第１端面
４３　第２端面
４５　連続的径変化部
Ｍ　観察物
Ｌ　照明光

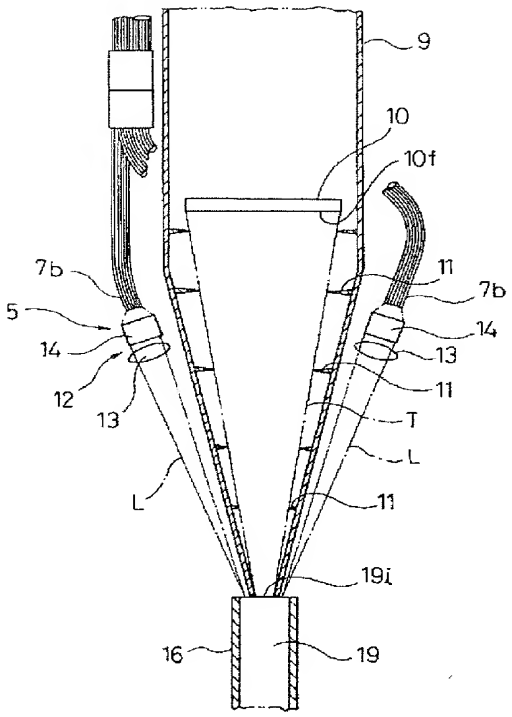
【図６】



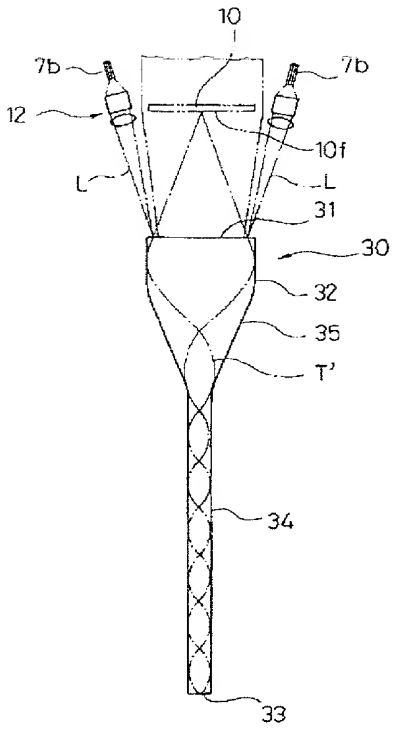
【図１】


8
6
1
2
4
7
7
5
14
13
12
L
14
13
L
19i
20
3
19
16
18
M
17

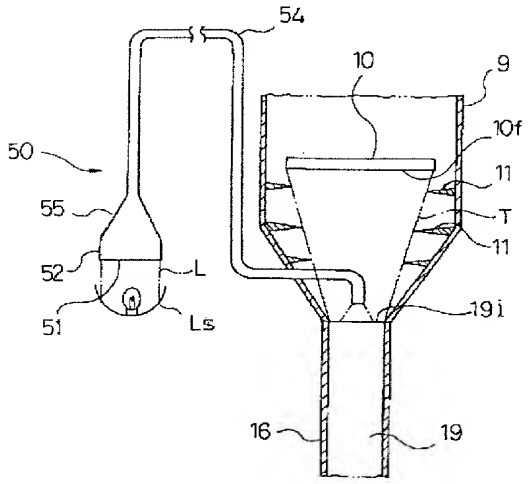
【図２】


9
10
10f
7b
11
7b
5
14
14
13
12
13
11
T
L
L
11
19i
16
19

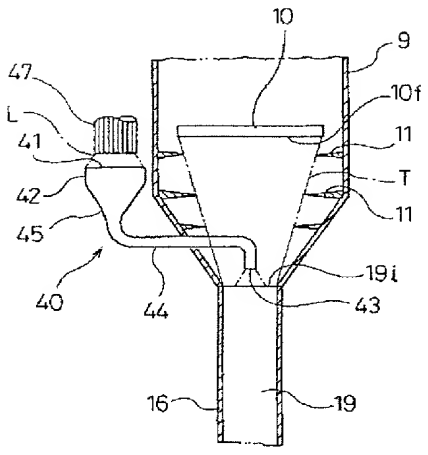
【図３】


10
7b
7b
12
10f
L
L
31
30
32
35
T'
34
33

【図５】


54
10
9
50
10f
11
55
T
11
52
L
51
Ls
19i
16
19

【図４】


10
9
47
10f
L
41
11
42
T
45
11
40
44
43
19i
16
19